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teleutospores, that this rust normally maintains itself by means of the hibernating uredospores.

In a paper which is the eleventh of a series of reports on his well-known cultural work with plant rusts, carried on since 1899, ARTHUR gives the results of the cultures of 1910.¹³ The work of that year was under the immediate charge of Miss IRMA A. UHDE. Sowings of spores of 21 species of rusts on a large number of possible aecidial hosts gave no infections. Successful cultures with 34 species supplemented or confirmed the results previously obtained either by the author or by other American and European investigators. The following six forms have been connected with their antithetic generation for the first time: *Puccinia Crandallii* Pam. & Hume on *Festuca confinis* Vasey and *Symphoricarpos racemosus* Michx.; *P. quadriporula* Arth. on *Carex Goodenovii* J. Gay and *Aster paniculatus* Lam.; *Puccinia Lithospermi* E. & K. on *Evolvulus pilosus* Nutt., autoecious; *Uromyces acuminatus* Arth. on *Spartina Michauxiana* A. S. Hitch. and *Polemonium reptans* L.; *Coleosporium Vernoniae* B. & C. on *Vernonia crinita* Raf. and *Pinus Taeda* L. (aecidiospores sown on *Vernonia*); and *Melampsora Albertensis* Arth. on *Populus tremuloides* Michx. and *Pseudotsuga mucronata* (Raf.) Sudw.

The host relations of some of the *Peridermium* rusts in Nova Scotia have been studied by FRASER,¹⁴ who, in addition to a number of field observations, reports cultures with the following forms. Teleutospores of *Melampsoropsis Cassandrae* (Peck and Clinton) Arth. from *Chamaedaphne calyculata* (L.) Moench sown on *Picea rubra* (Du Roi) Dietr. produced *Peridermium consimile* Arth. & Kern. Teleutospores of *M. abietina* (Alb. & Schw.) Arth. from *Sedum groenlandicum* Oeder also sown on *Picea rubra* produced *Peridermium abietinum* (Alb. & Schw.) Thüm. *M. ledicola* (Peck) Arth. from *Ledum* produced *Peridermium decolorans* Peck on *Picea canadensis*. One form, *Uromyces Peckiananus* Farlow on *Distichlis spicata* (L.) Greene, not belonging to the *Peridermium* rusts, produced aecidia on *Atriplex patula* var. *hastata* (L.) Gray and *Chenopodium album* L.

FISCHER'S¹⁵ review of the work done on the biology of rusts in 1910 will be of interest to students of this group.—H. HASSELBRING.

Cytology of the Basidiomycetes.—Among the many papers which have lately appeared on the cytology of the higher fungi, three are of more than usual interest. FRIES,¹⁶ in a brief paper on *Nidularia*, finds the mycelium and young basidia binucleated, the nuclei having the chromatin in two conspicuous masses. The nuclei increase in size with the growth of the basidium, gradually

¹³ ARTHUR, J. C., Cultures of Uredineae in 1910. *Mycologia* 4:7-33. 1912.

¹⁴ FRASER, W. P., Cultures of some heteroecious rusts. *Mycologia* 3:67-74. 1911.

¹⁵ FISCHER, ED., Die Publicationen über die Biologie der Uredineen in Jahre 1910. *Zeitschr. Bot.* 3:620-623. 1911.

¹⁶ FRIES, ROB. E., Über die cytologischen Verhältnisse bei der Sporenbildung von *Nidularia*. *Zeitschr. Bot.* 3:145. 1911.

approach, and fuse as they near the apex. The fusion nucleus increases greatly in size and forces the vacuoles, which had hitherto occupied a position between the nucleus and the end of the basidium, toward the periphery. Stages in this process are hard to follow because of the rapidity of development, but finally the single nucleole comes to lie in a tangle of chromatin in an otherwise clear nucleus. This seeming synapsis leads to a spireme stage which must be of rather long duration because of the many found. Parallel fibers are noted which become more conspicuous as the fibers shorten and segment, giving a characteristic diakinesis. At this stage the nuclear membrane has disappeared, but there is as yet no trace of spindle fibers. In the lower portion of the basidium there appears at this time a network of fibers, which finally partly surround the nuclear material, but which, however, seem to have nothing to do with the formation of the spindle. The long narrow spindle, seemingly of only three fibers, suddenly makes its appearance. Conspicuous centers are noted, but there is no trace of any radiations from either center. No definite equatorial plate was formed, but during anaphase 6-8 chromosomes were noted, one-half of which passed to either pole. No resting stage follows the division, the secondary spindles appearing at once, shorter, broader, and having two chromosomes at each pole when the process is completed. Four rather large nuclei are formed and gradually migrate toward the base of the basidium. Sterigmata develop and the nuclei become beak-shaped and pass into the developing spore and again divide. In some instances it was found that the nuclei begin to divide while still in the basidium, the process being completed when the spore is reached.

KNIEP¹⁷ finds in the mycelium from a single spore only one nucleus in each cell, and this condition persists even in cultures a year old. He finds in young cultures (3-4 weeks) that basidia are produced without the formation of a normal fruit body. These basidia may or may not be developed from terminal cells, and each contains a single nucleus. This is somewhat larger than the nuclei of the mycelium, but according to KNIEP is never due to a fusion. Each contains a conspicuous nucleole and a dense tangle of chromatic material connected to the nuclear membrane by numerous strands. The nucleus increases in size with the growth of the basidium, the nuclear material becomes granulated, at times parallel threadlike portions are noted, the nucleole decreases in size, and the dark-staining chromatic material becomes very much contracted. At this stage conspicuous double threads are observed. This stage, which very much resembles synapsis, precedes the formation of a spireme, during which the nucleus migrates to the apex of the basidium, where follows a rapid contraction of chromatic material accompanied by the disappearance of the nuclear membrane. KNIEP was able to count at this stage four masses of chromatin from which radiations extended into the cytoplasm, giving very

¹⁷ KNIEP, HANS, Ueber das Auftreten von Basidien im einkernigen Mycel von *Armillaria mellea* Fl. Dan. Zeitschr. Bot. 3:381. 1911.

much the appearance of a multipolar spindle. These fibers bear no relation to the true spindle which now makes its appearance. No centrosomes were observed, and only four chromosomes of which two passed to either pole. The chromosomes changed greatly in shape as they moved along the spindle, indicating a very plastic nature. The second division follows at once, giving rise to the nuclei which pass into the spores. In some instances a third division takes place within the basidium, and as a result there is a degeneration of four of the nuclei.

FRIES¹⁸ finds in *Hygrophorus conicus* that the cells of the trama contain one or more pair of nuclei, while the cells of the subhymenium have only a single nucleus, each having a conspicuous nucleole and two distinct masses of chromatin. Basidia, even the youngest, are uninucleated with the same double nature of the chromatic content. Growth of the basidium is accompanied by a corresponding growth in size of the nucleus, and the chromatin assumes the nature of a long delicate spireme thread. Following closely upon this there is a disappearance of the nuclear membrane and a sudden contraction of the spireme into a compact mass surrounded by a granular (plasma) cytoplasm. Spindle fibers now appear (no centrosome was found) and two chromosomes are seen to pass to each pole. The daughter nuclei, which at this stage lie near the apex of the basidium, are fully reconstructed and move toward the base of the basidium, where they remain while the sterigmata are developed. As soon as the sterigmata are fully formed, the nuclei in most cases become beaked and pass into the spore and divide; in other instances the division is partly completed in the basidium.

The first of these papers describes a process which is usually considered the typical method of nuclear behavior in the higher Basidiomycetes. We have here the fusion of nuclei, a synapsis, a spireme (double in its nature), a heterotypic followed by homotypic division.

In the second paper we have no fusion of nuclei, but stages are described and figures given which compare favorably with those of the preceding paper, although the author does not admit of chromosome reduction.

The third paper describes a form unique in that the cells of the trama contain more than one nucleus, while the basidium contains but one, and this according to the author is not a fusion nucleus. Therefore the division in the basidium is not a reduction division.—E. M. GILBERT.

Amanita.—Dr. RENÉ FERRY, former editor of the *Revue Mycologique*, has recently published a paper of a monographic nature dealing with the "deadly" Amanitas,¹⁹ with special reference to their botanical characters,

¹⁸ FRIES, ROB. E., Zur Kenntnis der Cytologie von *Hygrophorus conicus*. Svensk. Botanisk. Tidskrift 5: 242-251. 1911.

¹⁹ FERRY, RENÉ, Étude sur les Amanites; les Amanites mortelles. *Amanita phalloides*, *Amanita verna*, et *Amanita virosa*. Rev. Mycologique. Suppl. 1. pp. 1-96. pls. 1-8. 1911. Saint-Dié (Vosges), France. 4.50 fr. On sale by the author.